

Conservation Plantings for Natural Resources Management

Rangelands, Windbreaks, Wildlife Habitat, Soil Protection, Conservation Cover,
and Mined-Land Reclamation

Joint recommendations by:
University of Nevada Cooperative Extension
and the
U.S.D.A. Soil Conservation Service

Conservation Plantings for Natural Resources Management: Rangelands, Windbreaks, Wildlife Habitat, Soil Protection, Conservation Cover, and Mined-Land Reclamation

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SUMMARY

This is one in a series of publications relating adapted plant materials to various uses and soils in the different climatic regions of Nevada. This series has been developed by the University of Nevada Cooperative Extension and the Soil Conservation Service (SCS), U.S. Department of Agriculture. This series includes five publications: "Irrigated Forages for Northern Nevada-Type Climate" (BE-91-01), "Irrigated Forages for Western Nevada-Type Climate" (BE-91-02), "Irrigated Forages for Southern Nevada-Type Climate" (BE-91-03), "Management of Irrigated Forages in Nevada" (BE-91-04), and "Conservation Plantings for Natural Resources Management: Rangelands, Windbreaks, Wildlife Habitat, Soil Protection, Conservation Cover, and Mined-Land Reclamation" (BE-93-01, C-183 revised).

Bulletin BE-93-01 differs from others in the series in that it covers the entire state. This revision was completed during the year 1993. It is divided into six sections--Rangeland Plantings, Windbreak Plantings, Wildlife Plantings, Conservation Cover Plantings, Mined-Land Reclamation, and Appendices.

These recommendations were developed to serve as a common source of information for workers in crop agriculture, range management, environmental science, conservation and mined-land reclamation. Adjustments to meet special situations will be necessary, particularly when working with the harsh conditions encountered on Nevada wildlands. Local agricultural and resource specialists should be consulted for advice.

The climatic conditions and soil characteristics of Nevada vary to the extent that few species or varieties are adapted throughout. For example, the (32° F.) growing season ranges from 248 days at Las Vegas to 61 days at Wells. Average annual temperatures at these locations are 66° and 45° respectively. Elevations and rainfall patterns and intensities contrast to the same degree.

Plantings should therefore be selected for suitability to soils and climate and the availability of water. These considerations govern the recommendations for each of the major uses described.

ACKNOWLEDGEMENTS

These recommendations have been developed with the assistance of many specialists. Those who deserve special recognition include Richard E. Eckert ARS (retired), Don Klebenow UNR (retired), Jesse McWilliams SCS (retired) E.A. Naphan SCS (retired), Fred Peterson UNR (retired), and Norman R. Ritter SCS (retired).

Plant Hardiness Zone Map

These plant hardiness zones are from the national plant hardiness zone map (Agricultural Research Service, USDA Miscellaneous Publication 1475.)

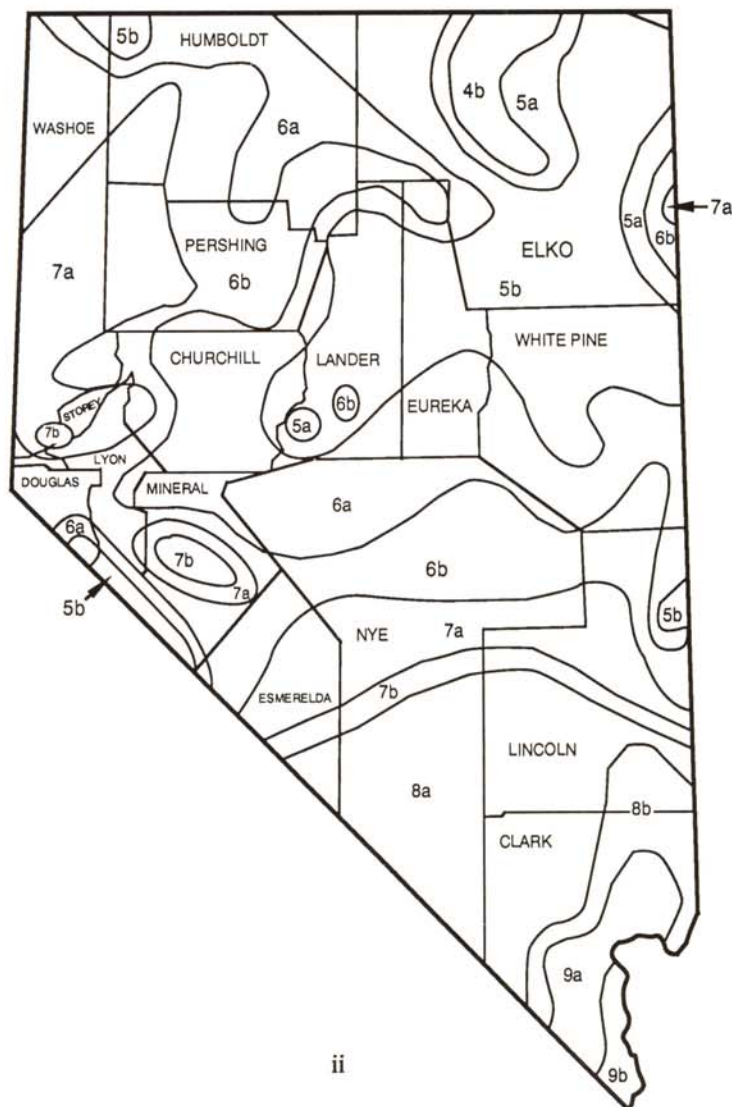
These zones are determined by the approximate range of average annual minimum temperatures. This map should be used as a general guide to plant hardiness. To determine if a certain plant will survive in a given area it is necessary to consider factors other than the minimum temperature range of each zone.

For some plants, rapid temperature changes may have more effect than low temperatures. The amount of snow cover during low temperature periods also affects plant survival. Temperatures for adjacent zones become increasingly similar near their boundaries. There are numerous climatic islands within each zone that may be considerably milder or colder than the zone average. This is especially true in hilly and mountainous areas. In urban areas, buildings, paving, and other structures create micro-climates in which plants that would not survive in the open countryside can be grown.

PLANT HARDINESS ZONES

Average annual minimum temperatures in Fahrenheit Zone

- 4b -20 to -25
- 5a -15 to -20
- 5b -10 to -15
- 6a -5 to -10
- 6b 0 to -5
- 7a 5 to 0
- 7b 10 to 5
- 8a 15 to 10
- 8b 20 to 15
- 9a 25 to 20
- 9b 30 to 25



CONTENTS

AUTHORS	i
SUMMARY	i
ACKNOWLEDGEMENTS	i
PLANT HARDINESS ZONE MAP	ii
RANGELAND PLANTINGS	1
Site Selection	1
Plant Materials	1
Cultural Techniques	2
Management	3
Table 1: Adaptation and Characteristics of Grasses and Legumes for Rangeland Plantings	3
Table 2: Pounds of Bulk Seed Required to Yield One Pound of Pure Live Seed	10
WINDBREAK PLANTINGS	11
Plant Materials	11
Establishment	11
Maintenance	11
Table 3: Adaptation and Characteristics of Trees, Shrubs, and Ground Cover Plants for Windbreaks, Conservation Cover, Wildlife and Landscape Use	12
WILDLIFE PLANTINGS	24
Wildlife Management Techniques for Cropland Areas, Hedgerows, Fencerows, and Field Borders ...	24
Wet Areas	25
Wildlife Management Techniques for Rangeland	25
Wildlife Considerations for Highways, Recreation and Rest Sites	25
CONSERVATION COVER PLANTINGS	26
Critical-Area Planting Guide	26
Planning	26
Site Preparation	26
Planting	27
Mulching	28
Table 4: Adaptation and Characteristics of Plants for Conservation Cover on Critical Areas	29
MINED-LAND RECLAMATION PLANNING	33
Appendix 1 - Key to Soils for Rangeland Plantings	35
Guide to Unsuitable Soil Conditions	35
Guide to Suitable Soil Conditions	35
Appendix 2 - Field Evidence for Identifying Soil Drainage Classes	37
Appendix 3 - Scientific and Common Plant Names	39
Appendix 4 - Recommended Varieties	45

CONSERVATION PLANTINGS FOR NATURAL RESOURCES MANAGEMENT, RANGELANDS, WINDBREAKS, WILDLIFE HABITAT, SOIL PROTECTION, CONSERVATION COVER AND MINED-LAND RECLAMATION.

RANGELAND PLANTINGS

This section focuses on improving rangelands for livestock, wildlife, and watershed protection. Research and field plantings have demonstrated that seeding rangeland is an exacting business requiring careful site and plant selection and cultural techniques. Climatic factors always impose a risk, but attention to controllable aspects will help to assure success.

Any seeding should be designed as a part of an overall range management system and ranch operation program.

Site Selection

The most desirable sites for range seeding have a climate with 10 or more inches of annual precipitation. These sites should have soils with good moisture-supplying capacities for plant growth. Appendix 1 suggests suitable rangeland soils for seeding.

Native plant indicators, when present, can be used in conjunction with Appendix 1 to help determine site suitability. Generally, soils supporting big sagebrush, bluebunch wheatgrass, Canby bluegrass, Thurber needlegrass, and lupine are suitable for seeding. Soils supporting low sagebrush, black sagebrush, black greasewood, bud sagebrush, or winterfat are less suitable. Rockiness, steepness of slope, and site droughtiness are the most common constraints.

Plant Materials

Table 1 lists grasses and legumes recommended for rangeland seeding and some important characteristics of these species. Seed of most native species is in short supply and is not often available. Efforts are underway to develop supplies of these materials.

In addition to the plants listed in Table 1 there are several shrub and forb species with high potential for Nevada rangeland plantings (Tables 3 and 4). Techniques for seeding and establishing these have not been perfected, but successful plantings have been established. Seeds are not readily available, but

increased supplies are expected to develop. Collection from natural stands is the primary seed source for native shrubs.

Some plants that have shown promise on Nevada rangelands are:

Australian saltbush (*Atriplex semibaccata*) -- An introduced forb or sub-shrub adapted to southern Nevada. Possible as a reseeding annual in other parts of the state. Drought and salt tolerant. Useful for livestock and wildlife forage and conservation cover. Some commercial seed available. Not frost tolerant.

Big saltbush (*Atriplex lentiformis*) -- Native in specific sites throughout Nevada. Drought and salt tolerant. Needs deep soil. Provides browse for livestock, and food and cover for wildlife. Well suited for conservation cover plantings.

Antelope bitterbrush (*Purshia tridentata*) -- An important native shrub. A preferred deer and livestock browse plant. An attractive plant for conservation cover. Well adapted in foothill areas with 10 inches or more annual rainfall. Seed predation by rodents is a problem in seedings. Some commercial seed is available. The cultivar Lassen is recommended for western Nevada.

Fourwing saltbush (*Atriplex canescens*) -- Widely adapted native shrub. Drought and salt tolerant. A browse plant for livestock and wildlife. Well suited for conservation cover plantings. The seed from local native collections is best adapted. Wytana, a variety released in Wyoming and Montana, is probably adapted to northern Nevada areas. Rincon is adapted throughout much of the rest of the state.

Prostrate kochia (*Kochia prostrata*) -- An introduced forb or sub-shrub. Drought and salt tolerant. Produces high quality forage for both livestock and wildlife. Limited seed supply. The cultivar Immigrant is now available.

Shadscale (*Atriplex confertifolia*) -- The most drought tolerant of the native saltbushes. Is also salt tolerant. Provides forage for livestock and wildlife. Is a good conservation cover in low rainfall areas.

Small burnet (*Sanguisorba minor*) -- An introduced forb. Valuable for livestock and wildlife forage. Especially good for deer. Adapted in pinyon-juniper zones with 12 inches or more precipitation. Usually a good seed producer. Variety Delar has preformed well throughout small burnet's area of adaptation.

Winterfat (*Ceratoides lanata*) -- Also called whitesage. A drought resistant, low shrub native to dry, sandy, or deep silty soils over most of Nevada. Good livestock forage and also valued for wildlife. Usually a good seed producer. Do not process winterfat seeds to remove woolly covering even though drilling is complicated. Seed very shallow in cool weather. Some commercial seed available. Pamir winterfat (*Ceratoides latens*) has been introduced experimentally from Afghanistan. It is a much better producer than our whitesage and deserves further consideration.

These plants are usually seeded in mixtures with grasses. However, pure plantings may be desired on some sites. Seeding rates vary depending on seed quality and the percentage of shrubs desired in the planting. The percentage of pure live seed in seed collected from native plants is likely to be low. Most shrub seeds will need some processing before they can be planted with normal range seeding equipment.

A number of plants listed in Table 1 are adapted to more than one group of soils. Most of these are wheatgrasses with relatively wide ranges of site suitability. The final selection of species, if more than one is adapted, should be determined by the management plan and grazing animals. Although crested, desert, and Siberian wheatgrasses are adapted to both low and high precipitation sites, selecting another grass such as intermediate or pubescent wheatgrass may gain higher production, better livestock acceptability during the desired grazing period, or a longer green feed season.

Cultural Techniques

Ideal conditions for rangeland seedings are comparable to cropland requirements. In practice, this is seldom attainable. The risk of failure can be

minimized, however, by using good farming practices whenever possible.

Some important considerations are:

1. Seedbed preparation should remove as much competing vegetation as possible and leave the soil relatively firm for planting. Fertilization is not recommended for establishment.

2. Use certified seed if available. If not, use the best quality seed that can be obtained. Adjust seeding rates according to pure live seed content (Table 2).

3. Mixtures can include grasses, forbs and shrubs. Mixtures are generally recommended. Because of establishment and management difficulties, however, it is important to select plants that are compatible in adaptation and use. Single species plantings are more susceptible to damage by insects and disease than are mixtures of species.

4. Most grasses, especially wheatgrass, planted on Western ranges are highly susceptible to the fungus *Podosporella verticillata*. To reduce loss, suppliers may apply a fungicide to the seed. Few fungicides, if any, are available for rangeland use. Rodents can also be a problem, especially with shrub and forb seed. These seeds should be treated with a rodent repellent. All chemicals and chemically-treated seed must be used, stored or disposed of according to label directions and prescribed state or federal regulations.

5. Planting should be done using a deep-furrow drill with 12- to 16-inch spacing or a deep, wide furrow drill with 18- to 20-inch spacing. Plant the seed in the bottom of the furrows without a drag. Press wheels may be helpful. A deep furrow drill is not adapted to all soils.

6. Group III and IV soils (see Appendix 1) supporting big sagebrush or juniper have been successfully seeded by chain dragging twice in opposite directions. Seed should be broadcast between chaining.

7. Late fall planting is generally recommended. Early fall or spring planting increases risks, but early spring planting can be successful, particularly if weed control (chemical or mechanical), is practiced. However, virtually all herbaceous weed

control treatments for rangelands no longer have valid registration with the Environmental Protection Agency.

8. Seedlings should be protected from grazing until they are firmly established, (usually two years.)

Management

1. Grazing should be based on a management system geared to the physiology of the key forage plants. The system must provide for periodic deferment of grazing to maintain plant vigor and assure reproduction. Seedlings of different grasses with noncompatible use periods should be fenced into separate units to allow proper management.

For example, crested, desert, or siberian wheatgrass should be separated from intermediate, pubescent, or bluebunch wheatgrasses to avoid intensive management.

2. Palatability and nutritive quality of forage plants change with plant growth stages. These changes must be taken into account in the grazing management system through adjustments in season and intensity of use.

3. Herbage yield varies with the site and current growing conditions. Annual variations of as much as 300 percent are common. The number of animals or the days of use must be adjusted accordingly.

TABLE 1
Adaptation and Characteristics of Grasses and Legumes for Rangeland Plantings
GRASSES AND LEGUMES

Species	Drought tolerance ¹	Minimum annual rainfall needs ²	Salt & alkali tolerance	Seedling vigor	Growth habit	Suitable soil groups ³	Seeding rates lb/ac. PLS ⁴	Seed/Sq. Ft. @ 1 lb. PLS/Ac.	Remarks
Alfalfa (<i>Medicago sativa</i>)	Mod.	10-12	Mod.	High	Bunch	II, IV	4	6	Good forage for livestock and wildlife; soil improvement
Alkali sacaton (<i>Sporobolus airoides</i>)	High	6-8	High	Low	Bunch	I, II	2	31	Native; warm season species difficult to establish without summer rainfall
Birdsfoot trefoil (<i>Lotus corniculatus</i>)	Low	12-14	Mod.	Low	Bunch	I, II, IV	4	10	Tolerates high water table; good livestock and wildlife forage

(Table 1 continued)

GRASSES AND LEGUMES

Species	Drought tolerance ¹	Minimum annual rainfall needs ²	Salt & alkali tolerance	Seedling vigor	Growth habit	Suitable soil groups ³	Seeding rates lb/ac. PLS ⁴	Seed/Sq. Ft. @ 1 lb. PLS/Ac.	Remarks
Bluegrass, big (<i>Poa sandbergii</i>)	High	10-12	Mod.	Mod.	Bunch	III, IV	3	19	Native; highly palatable; stays green as long as moisture is available
Bluegrass, Canby (<i>Poa sandbergii</i>)	Mod.	8-10	Mod.	Mod.	Bunch	III, IV	5	25	Native, early spring grower, not highly productive
Bluegrass, Sandberg (<i>Poa sandbergii</i>)	Mod.	8-10	Mod.	Mod.	Bunch	III, IV	5	25	Native; early spring grower; not highly productive
Bottlebrush squirreltail (<i>Elymus elymoides</i>)	High	6-10	Mod.	Mod.	Bunch	II, III, IV	8	4	Native; very drought tolerant; seed difficult to handle
Brome, mountain (<i>Bromus marginatus</i>)	Mod.	12-14	Low	Mod.	Bunch	IV	10	2	Native; adapted at higher elevations in northern Nevada
Brome, smooth (<i>Bromus inermis</i>)	Mod.	10-12	Mod.	High	Sod	II, IV	10	4	Highly palatable; need high fertility for good production
Brome, Turkish (<i>Bromus erectus</i>)	Mod.	10-12	Low	High	Bunch	II, IV	5	5	Needs good drainage; good regrowth
Cicer milkvetch (<i>Astragalus cicer</i>)	Mod.	10-12	Mod.	Low	Sod	II, IV	10	3	Cold hardy; difficult to establish in competition with weeds; long lived

(Table 1 continued)

GRASSES AND LEGUMES

Species	Drought tolerance ¹	Minimum annual rainfall needs ²	Salt & alkali tolerance	Seedling vigor	Growth habit	Suitable soil groups ³	Seeding rates lb/ac. PLS ⁴	Seed/Sq. Ft. @ 1 lb. PLS/Ac.	Remarks
Creeping meadow foxtail (<i>Alopecurus arundinaceus</i>)	Mod.	16+	Low	Mod.	Sod	I, II	4	20	Mountain or other wet sites; flood tolerant
Fescue, Idaho (<i>Festuca idahoensis</i>)	Mod.	12-14	Low	Mod.	Bunch	IV	4	10	Native; best adapted at higher elevations in northern Nevada
Fescue, tall (<i>Festuca arundinacea</i>)	Mod.	16+	Mod.	High	Bunch	II	8	6	Recommended for mountain meadows. Goar variety used in southern Nevada.
Flatpea (<i>Lathyrus sylvestris</i>)	Mod.	12-14	Low	Mod.	Sod	II, IV	40	7	Viny spreading plant; forage for livestock and wildlife; good for erosion control
Galleta (<i>Hilaria jamesii</i>)	High	8-10	Mod.	Low	Sod	II, III, IV	8	4	Native; best adapted in central and southern Nevada
Indian ricegrass (<i>Oryzopsis hymenoides</i>)	High	6-10	Mod.	Mod.	Bunch	III, IV	6	5	Native; good cured forage; best adapted to sandy soils; grows in cycles
Purple prairieclover (<i>Petalostemum purpureus</i>)	Mod.	12-14	Low	Low	Bunch	II, IV	4	7	Native; best adapted in northern and eastern Nevada

(Table 1 continued)

GRASSES AND LEGUMES

Species	Drought tolerance ¹	Minimum annual rainfall needs ²	Salt & alkali tolerance	Seedling vigor	Growth habit	Suitable soil groups ³	Seeding rates lb/ac. PLS ⁴	Seed/Sq. Ft. @ 1 lb. PLS/Ac.	Remarks
Reed canarygrass (<i>Phalaris arundinacea</i>)	Mod.	16+	Low	Mod.	Sod	I, II	5	13	Mountain meadows; flood tolerant; can be established by sprigging on wet sites
Sainfoin (<i>Onobrychis viciifolia</i>)	Mod.	12-14	Low	Mod.	Bunch	II, IV	25	40	Excellent deer forage; best suited to coarse, textured soils
Sand dropseed (<i>Sporobolus cryptandrus</i>)	High	8-10	Low	Mod.	Bunch	III, IV	1/2	129	Native; adapted to sandy soils; not very palatable after curing
Wheatgrass, beardless (<i>Agropyron inerme</i>)	High	8-10	Mod.	Mod.	Bunch	III, IV	8	3	Native; best adapted in northern, central and eastern Nevada
Wheatgrass, bluebunch (<i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>)	Mod.	10-12	Low	Mod.	Bunch	III, IV	8	2	Native; best adapted in northern and eastern Nevada
Wheatgrass, crested (<i>Agropyron cristatum</i>)	High	8-10	Mod.	High	Bunch	II, III, IV	5	7	Tendency to sod; usually produces less than desert wheatgrass
Wheatgrass, crested hybrid (<i>Elytrigia repens</i> X <i>Pseudoroegneria spicata</i>)	High	8-10	Mod.	High	Bunch	II, III, IV	5	5	Similar to parentage

(Table 1 continued)

GRASSES AND LEGUMES

Species	Drought tolerance ¹	Minimum annual rainfall needs ²	Salt & alkali tolerance	Seedling vigor	Growth habit	Suitable soil groups ³	Seeding rates lb/ac. PLS ⁴	Seed/Sq. Ft. @ 1 lb. PLS/Ac.	Remarks
Wheatgrass, desert (<i>Agropyron desertorum</i>)	High	8-10	Mod.	High	Bunch	II, III, IV	5	5	Good early spring producer; not as drought tolerant as Siberian wheatgrass
Wheatgrass, intermediate (<i>Elytrigia intermedia</i>)	Mod.	10-12	Low	High	Sod	II, IV	8	2	Not adapted to poorly or somewhat poorly drained soils
Wheatgrass, pubescent (<i>Elytrigia intermedia</i>)	Mod.	10-12	Low	High	Sod	II, IV	8	2	Slightly more drought tolerant than inter- mediate. Luna variety best
Wheatgrass, Siberian (<i>Agropyron fragile</i> ssp. <i>sibiricum</i>)	High	8-10	Mod.	High	Bunch	II, III, IV	5	5	Stays green longer than desert wheat- grass and is slightly more drought tolerant
Wheatgrass, slender (<i>Elymus trachycaulus</i> ssp. <i>trachycaulus</i>)	Mod.	12-14	Mod.	High	Bunch	II, IV	8	3	Native; best used in mixtures; recommended for mountain meadows
Wheatgrass, streambank (<i>Elymus lanceolatus</i> ssp. <i>lanceolatus</i>)	High	8-10	Mod.	Mod.	Sod	II, III, IV	10	4	Low forage production; good for erosion control
Wheatgrass, tall (<i>Elytrigia elongata</i>)	High	12-14	High	Mod.	Bunch	I, II, IV	10	2	High producer; good for late summer use

(Table 1 continued)

GRASSES AND LEGUMES

Species	Drought tolerance ¹	Minimum annual rainfall needs ²	Salt & alkali tolerance	Seedling vigor	Growth habit	Suitable soil groups ³	Seeding rates lb/ac. PLS ⁴	Seed/Sq. Ft. @ 1 lb. PLS/Ac.	Remarks
Wheatgrass, thickspike (<i>Elymus lanceolatus</i> ssp. <i>lanceolatus</i>)	High	10-12	Mod.	High	Sod	II, III, IV	8	3	Native; fair forage production; good for erosion control
Wheatgrass, western (<i>Pascopyron smithii</i>)	High	10-12	High	Mod.	Sod	II, III, IV	10	3	Native; best adapted in northern and eastern Nevada; good for erosion control
Wildrye, basin (<i>Leymus cinereus</i>)	High	10-12	High	Mod.	Bunch	II, IV	8	4	Native; good winter forage; does not tolerate close summer grazing
Wildrye, Russian (<i>Psathyrostachys juncea</i>)	High	10-12	Mod.	Mod.	Bunch	II, III,	8	8	Good cured forage for fall and winter; not a good erosion control plant
Yellow sweetclover (<i>Melilotus officinalis</i>)	Mod.	10-12	Mod.	High	Bunch	II, III, IV	4	6	Biennial; good for establishing initial cover; reseeds well

¹ In relation to adapted sites.

² It is difficult to establish stands in areas of less than 10-inch annual rainfall.

³ See "Key to Soils for Rangeland Plantings," Appendix 1.

⁴ PLS is pure live seed. See chart page 10 on how to convert PLS to actual seeding rate. Rates are for single species plantings.

DETERMINING SEEDING RATES FOR MIXTURES

Calculation of seed amounts required for a specific selected mixture requires accounting for varying seed size and plant community type; i.e. grass-forb, shrub or tree (Note: Separate seed mix(es) should be developed for each plant community type). The procedure is as follows:

(Table 1 continued)

1. Determine desired number of seeds per square ft. The standard Soil Conservation Service specification is 20 seeds/sq. ft. unless the seeded area is a harsh environment (Critical Area). Critical Area specification is 40 seeds/sq. ft.
2. Determine the desired component mix; for example 50% Crested wheatgrass, 30% Indian ricegrass and 20% Sainfoin. (Note that this is percentage by number of plants, not size of plants)
3. Determine the estimated number of seeds per pound for the chosen species. This information is available in many seed catalogs, or from the SCS.
4. Perform the following calculations:
 - a. Desired seeds/sq. ft. multiplied by % of species in mix gives the number of seeds of that species/ sq. ft. i.e. (50% Crested wheatgrass. $[40 \text{ lb} \times .50 \text{ (Crested wheatgrass)} = 20 \text{ lb sds/sq. ft.}]$).
 - b. Multiply the above product (20) by the square feet in 1 acre. $[20 \times 43,560 = 871,200 \text{ sds/ac.}]$.
 - c. Divide the above product (871,200) by number of seeds per pound in 1 pound of Crested wheatgrass $[871,200 \div 152,800 = 5.7 \text{ lbs. of crested wheatgrass per ac.}]$
 - d. Multiply the above product (20) by the number of pounds of bulk seed required to yield one pound of pure live seed (See Table 2).
 - e. Repeat process for each species in mix. All calculations are Pure Live Seed (PLS).
 - f. Seed at the rate of the total for all species.

Table 2. Pounds of bulk seed required to yield one pound of pure live seed.

(Prepared by Craig Plummer, Soil Conservation Service)

Percent Germination

% Purity	100	95	90	85	80	75	70	65	60	55	50	45	40
100	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.3	2.5
95	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.2	2.4	2.7
90	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.8	1.9	2.1	2.3	2.5	2.8
85	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.9	2.0	2.2	2.4	2.7	3.0
80	1.3	1.4	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.3	2.5	2.8	3.2
75	1.4	1.5	1.5	1.6	1.7	1.8	2.0	2.1	2.3	2.5	2.7	3.0	3.4
70	1.5	1.6	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.6	2.9	3.2	3.6
65	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.4	2.6	2.8	3.1	3.5	3.9
60	1.7	1.8	1.9	2.0	2.1	2.2	2.4	2.6	2.8	3.1	3.4	3.8	4.2
55	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.8	3.1	3.4	3.7	4.1	4.6
50	2.0	2.2	2.3	2.4	2.5	2.7	2.9	3.1	3.4	3.7	4.0	4.5	5.0
45	2.3	2.4	2.5	2.7	2.8	3.0	3.2	3.5	3.8	4.1	4.5	5.0	5.6
40	2.5	2.7	2.8	3.0	3.2	3.4	3.6	3.9	4.2	4.6	5.0	5.6	6.3
35	2.9	3.1	3.2	3.4	3.6	3.9	4.1	4.4	4.8	5.7	5.8	6.4	7.2
30	3.4	3.6	3.8	4.0	4.2	4.5	4.8	5.2	5.6	6.1	6.7	7.5	8.4
25	4.0	4.3	4.5	4.8	5.0	5.4	5.8	6.2	6.7	7.3	8.0	8.9	10.0
20	5.0	5.3	5.6	5.9	6.3	6.7	7.2	7.7	8.4	9.1	10.0	11.2	12.5
15	6.7	7.1	7.5	7.9	8.4	8.9	9.6	10.3	11.2	12.2	13.4	14.9	16.7
10	10.0	10.6	11.2	11.8	12.5	13.4	14.3	15.4	16.7	18.2	20.0	22.3	25.0

WINDBREAK PLANTINGS

Windbreaks are planted to protect soil, crops, livestock and buildings. In summer they protect gardens, orchards and field crops and reduce wind erosion. In winter they control snow drifting, protect livestock, and may reduce some fuel consumption in the home. Windbreaks also provide food and cover for wildlife, particularly song and game birds, and enhance the beauty of the landscape.

Plant Materials

Windbreaks are established from rooted stock or cuttings. Table 3 lists and describes the characteristics of recommended plant materials. New species and varieties are being tested. These include native and introduced plants as well as plants that are being developed for drought resistance and cold, alkali, and salt tolerance.

Establishment

Ideally, windbreaks should be planted on the windward side at least 100 feet from the area to be protected. Single row plantings can be used, but two to three rows are needed for good protection. In some areas, five to seven rows are required for effective protection. The trees must be dense and high enough to reduce wind velocity. At least one row of evergreens for winter protection and at least one row of deciduous trees for increased summer protection should be used. Temporary protection of evergreen plantings from sun and wind is recommended. This can be provided by parallel plantings of grain or corn on both sides of the row. In areas of snow accumulation, windbreaks should not be located adjacent to roads, especially on the windward side of heavily traveled roads.

Low-growing shrubs should be planted on the windward side to prevent wind from sweeping under the windbreak. Spacing of plants within rows should be as follows:

- Small shrubs -- 1 to 4 feet apart
- Large shrubs and small trees -- 5 to 8 feet apart
- Large trees -- 10 to 12 feet apart

There should be at least 12 feet between rows. More space is desirable between evergreen and deciduous rows to prevent overtopping. Clean cultivation is important for establishment, survival, and maximum growth.

Double rows of Tall wheatgrass or Basin wildrye spaced 20 feet to 60 feet apart make effective wind buffers for erosion control.

Giant reed (*Arundo donax*) makes a good single row windbreak in zones 7, 8 and 9. It grows to 15 feet high with adequate irrigation.

An irrigation system must be installed by planting time so the site can be watered before and immediately after planting and at least once each week through the first summer. Deep watering is essential for root development. In western and northern Nevada, irrigation should be reduced in the early fall so that deciduous trees have time to "harden-off." Winter irrigation of evergreens may be necessary to prevent drought losses.

Maintenance

Windbreaks must be protected from livestock, fire, rodents, rabbits, porcupines, and deer. Placing wire cylinders, aluminum foil or paper around the trunk or using rabbit and deer repellent paint is effective. Insect control may also be necessary. If a plant is lost it should be replaced as soon as possible. This is particularly important during the first few years. A good windbreak should have uniform density and height.

Some windbreak and critical area cover plants are available from Nevada Division of Forestry nurseries. Others can be obtained from commercial nurseries in Nevada or adjoining states.

TABLE 3
Adaptation and Characteristics of Trees, Shrubs and Ground Cover Plants
for Windbreaks, Conservation Cover, Wildlife and Landscape Use

DECIDUOUS TREES

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Ash, Arizona or velvet (<i>Fraxinus velutina</i>)	40	Mod.	Mod.	Mod.	Mod.	Low	7-9		Not winter hardy; damaged by 0° Fahrenheit or lower
Ash, green (<i>Fraxinus pennsylvanica</i>)	60	Mod.	Long	Mod.	Mod.	Mod.	4-6		Good shade and windbreak tree
Black locust ^{m4} (<i>Robinia pseudoacacia</i>)	50	Fast	Long	Low	Low	Low	5-7	X	Critical area plantings; drought hardy
Bur oak (<i>Quercus macrocarpa</i>)	100	Slow	Long	Mod.	Mod.	Low	4-6	X	Good for land- scaping
Common chokecherry (<i>Prunus virginiana</i>)	25	Mod.	Long	Mod.	Mod.	Mod.	4-6	X	Thicket forming; native fruit used for wine and jelly; not adapted for southern Nevada
Crabapple, flowering (<i>Malus pumila</i>)	25	Mod.	Long	Mod.	Mod.	Low	4-6	X	Numerous horti- cultural varieties available; good for landscaping
Crabapple, Manchurian (<i>Malus baccata mandshurica</i>)	25	Mod.	Long	Mod.	Mod.	Low	4-6	X	Good in wind- breaks; variety Midwest recently released
Eastern redbud (<i>Cercis canadensis</i>)	30	Mod.	Mod.	Mod.	Mod.	Low	5a-7	X	Ornamental; spring flower- ing

(Table 3 continued)

DECIDUOUS TREES

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Elm, American (<i>Ulmus americana</i>)	100	Fast	Long	Mod.	Mod.	Low	4-6		Good shade tree, but subject to disease and insect damage. Honey- dew drip problems
Elm, Siberian (<i>Ulmus pumila</i>)	40	Fast	Long	Low	Mod.	High	4-8		Good in windbreaks; drought tolerant; subject to breakage, insects; invasive roots; honeydew drip problems
Fremont Cottonwood (<i>Populus fremontii</i>) ^m	70	Fast	Mod.	Mod.	High	Mod.	4-6		Fast growing; natural tree; use male plants only
Fruitless mulberry (<i>Morus alba sribling</i>)	35	Fast	Short	High	High	High	5a-8		Shade and street tree; windbreaks
Ginkgo (<i>Ginkgo biloba</i>)	40	Slow	Long	Mod.	Mod.	Low	4-8		Good street tree; use male plants only
Hackberry (<i>Celtis occidentalis</i>)	65	Slow	Long	Mod.	Low	Low	6-9	X	Good shade and street tree
Hackberry, netleaf (<i>Celtis laevigata</i> var. <i>reticulata</i>)	50	Slow	Long	Mod.	Low	Low	6-9	X	Good shade and street tree
Honeylocust (<i>Gleditsia triacanthos</i>)	60	Mod.	Long	Mod.	Low	Low	6-9	X	Shade and land- scaping; several cultural varieties available

(Table 3 continued)

DECIDUOUS TREES

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Maple, Amur (<i>Acer ginnala</i>)	25	Fast	Mod.	Mod.	Mod.	Low	4-6	X	Good for landscaping, windbreaks and cover plantings
Maple, Norway (<i>Acer platanoides</i>)	60	Fast	Mod.	Mod.	Mod.	Low	4-6	X	Good shade tree
Poplar, Boleana (<i>Populus alba boleana</i>)	80	Fast	Short	High	High	Low	4-7		All poplars subject to fungal diseases and invasive roots
Poplar, Italian hybrid (<i>Populus X</i>)	80	Fast	Mod.	High	High	Mod.	4-7		Good vigor; very fast growing windbreak tree
Poplar, Lombardy (<i>Populus nigra</i>)	70	Fast	Long	High	High	Mod.	4-7	X	Windbreaks; skyline decoration
Poplar, Robusta (<i>Populus robusta</i>)	80	Fast	Mod.	High	High	Mod.	4-7	X	Windbreaks
Poplar, Siouxi (<i>Populus deltoides</i>)	100	Fast	Mod.	High	High	Mod.	4-6		Hardy; resistant to leaf rust; use male plants only
Russian olive ^m (<i>Elaeagnus angustifolia</i>)	30	Fast	Mod.	Low	High	High	4-8	X	Good windbreak and wildlife tree; critical area cover
Sycamore, American (<i>Platanus occidentalis</i>)	80	Fast	Long	Mod.	Mod.	Mod.	5-7		Good shade and street tree; windbreaks
Sycamore, California (<i>Platanus racemosa</i>)	80	Fast	Long	High	Mod.	Mod.	7-9		Good shade and street tree; good windbreaks
Thinleaf alder (<i>Alnus incana</i> ssp. <i>tenuifolia</i>)	25	Mod.	Mod.	High	High	Low	4-6	X	Thicket forming; good on stream banks; natural

(Table 3 continued)

DECIDUOUS TREES

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Tree-of-heaven (<i>Ailanthus altissima</i>)	50	Fast	Long	Low	Mod.	Mod.	5-9		Good for wind-breaks; critical area cover; will sucker and spread
Washington hawthorn (<i>Crataegus phaenopyrum</i>)	25	Mod.	Mod.	Low	Mod.	Low	4-6	X	Good for landscaping; other wildlife; other varieties available
Willow, golden (<i>Salix alba</i> var. <i>vitellina</i>)	40	Fast	Mod.	Mod.	High	Mod.	4-8		Good ornamental; plant near streambanks; do not plant near sewer lines
Willow, laurel (<i>Salix pentandra</i>)	60	Fast	Mod.	Mod.	High	Mod.	4-8		Good ornamental; do not plant near sewer lines

EVERGREEN TREES

Arbovitae (<i>Platycladus orientalis</i>)	25	Mod.	Long	Mod.	Mod.	Mod.	4-8	X	Good for landscaping and wind-breaks; a number of varieties are available
Athel (<i>Tamarix aphylla</i>)	40	Fast	Long	Low	High	High	7-9	X	Windbreaks; can grow other plants under Athel
Blue paloverde (<i>Parkinsonia florida</i>)	20	Mod.	Long	Low	Mod.	Low	8-9		Low maintenance landscaping

(Table 3 continued)

EVERGREEN TREES

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Cypress, Arizona (<i>Cupressus arizonica</i>)	40	Mod.	Long	Low	Mod.	Low	7-9	X	Good for wind-breaks, landscaping
Cypress, Italian (<i>Cupressus sempervirens</i>)	30	Mod.	Long	Mod.	Mod.	Low	7-9	X	Columnar or pyramidal forms available
Eucalyptus, bluegum (<i>Eucalyptus globulus</i>)	100	Fast	Long	Mod.	Mod.	Mod.	8-9		Good for wind-breaks; shade
Eucalyptus, whitegum (<i>Eucalyptus viminalis</i>)	60	Fast	Long	Mod.	Mod.	Mod.	8-9		Windbreaks and shade; more cold hardy than <i>E. globulus</i>
Giant sequoia (<i>Sequoiadendron giganteum</i>)	200	Fast	Long	High	Mod.	Low	5-7		Ornamental; landscaping
Joshua tree (<i>Yucca brevifolia</i>)	25	Slow	Long	Low	Low	Mod.	7-8		Low maintenance landscaping
Pine, Afghanistan (<i>Pinus brutia eldarica</i>)	50	Fast	Mod.	Low	Low	Mod.	6-9	X	Good form; Christmas trees; several varieties
Pine, aleppo (<i>Pinus halepensis</i>)	50	Fast	Mod.	Mod.	Low	Mod.	7-9	X	Windbreaks; ornamental; poor form
Pine, Austrian (<i>Pinus nigra</i>)	100	Fast	Short	Low	Low	Low	5-7	X	Windbreaks; ornamental
Pine, Japanese black (<i>Pinus thunbergii</i>)	50	Fast	Long	Mod.	Low	Low	5-7	X	Ornamental; windbreaks
Pine, Jeffrey (<i>Pinus jeffreyi</i>)	100	Slow	Long	Low	Low	Low	5-7	X	Windbreaks; ornamental
Pine, ponderosa ^m (<i>Pinus ponderosa</i>)	100	Slow	Long	Low	Low	Low	5-7	X	Ornamental; windbreaks; native

(Table 3 continued)

EVERGREEN TREES

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Pine, Scotch (<i>Pinus sylvestris</i>)	50	Mod.	Long	Low	Low	Low	5-7	X	Windbreak; shade
Pine, singleleaf pinyon ^m (<i>Pinus monophylla</i>)	30	Slow	Long	Low	Low	Low	5-7	X	Native; state tree; ornamental; low maintenance landscaping
Rocky Mountain juniper (<i>Juniperus scopulorum</i>)	25	Slow	Long	Low	Mod.	Mod.	4-7	X	Screening; wind- breaks; critical areas; ornamental; native
Spruce, Colorado blue (<i>Picea pungens</i>)	80	Slow	Long	Mod.	Mod.	Low	4-6	X	Windbreaks; landscaping
Spruce, Engelmann (<i>Picea engelmannii</i>)	80	Slow	Long	Mod.	Low	Low	4-6	X	Windbreaks; landscaping
Spruce, Norway (<i>Picea abies</i>)	80	Slow	Long	Mod.	Mod.	Mod.	4-6	X	Windbreaks; landscaping; needs full sun

DECIDUOUS SHRUBS

American plum (<i>Prunus americana</i>)	20	Mod.	Mod.	Mod.	Low	High	4-6	X	Native; wildlife; windbreaks; erosion control; fruit
Amur privet (<i>Ligustrum amurense</i>)	12	Fast	Long	Mod.	Mod.	Low	4-6	X	Windbreaks; screening; hedges; land- scaping
Antelope bitterbrush ^m (<i>Purshia tridentata</i>)	10	Mod.	Long	Low	Low	Low	4-6	X	Native; wildlife and livestock forage and erosion control

(Table 3 continued)

DECIDUOUS SHRUBS

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Big saltbush (<i>Atriplex lentiformis</i>)	8	Fast	Mod.	Low	High	High	5a-9	X	Native; erosion control; wildlife
Bladdersenna (<i>Colutea arborescens</i>)	10	Slow	Mod.	Low	Mod.	Low	6-9		Ornamental; landscaping
Blue elderberry ^m (<i>Sambucus cerulea</i>)	10	Fast	Long	Mod.	Mod.	Low	4-6	X	Native; landscaping; erosion control; fruit
Common snowberry ^m (<i>Symphoricarpos albus</i>)	4	Fast	Mod.	Mod.	Low	Low	4-6	X	Native; wildlife; erosion control; low maintenance; landscaping
Cotoneaster, Peking (<i>Cotoneaster acutifolius</i>)	6	Mod.	Long	Mod.	Mod.	Low	4-7	X	Good hedge plant
Cotoneaster, rockspray (<i>Cotoneaster microphyllus</i>)	2	Mod.	Long	Mod.	Low	Low	4-7	X	Ground cover; landscaping
Currant, golden ^m (<i>Ribes aureum</i>)	5	Fast	Long	Low	Mod.	Mod.	4-7	X	Native; wildlife; windbreaks; erosion control; fruit
Currant, wax (<i>Ribes cereum</i>)	4	Fast	Mod.	Mod.	Mod.	Mod.	4-6	X	Native; wildlife; erosion control
Desertwillow (<i>Chilopsis linearis</i>)	20	Fast	Long	Low	Mod.	Mod.	7-9		Native; windbreaks; low maintenance landscaping; spring flowers; southern Nevada
Flowering almond (<i>Prunus triloba</i>)	6	Mod.	Mod.	Mod.	Low	Low	5-7		Ornamental; flowers in early spring; pink or white

(Table 3 continued)

DECIDUOUS SHRUBS

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Forsythia (<i>Forsythia</i>)	6	Mod.	Mod.	Mod.	Mod.	Low	5-7		Landscaping; erosion control; tolerates low fertility
Fourwing saltbush (<i>Atriplex canescens</i>)	6	Mod.	Mod.	Low	Mod.	High	4-8	X	Native; erosion erosion control; wildlife; low maintenance landscaping
Fremont dalea (<i>Dalea fremontii</i>)	4	Mod.	Long	Low	Mod.	Mod.	7-9	X	Native; low maintenance landscaping
Honeysuckle, tatarian (<i>Lonicera tatarica</i>)	12	Mod.	Long	Mod.	Mod.	Mod.	4-8	X	Wildlife; wind- break; landscaping
Honeysuckle, twinberry (<i>Lonicera involucrata</i>)	8	Fast	Mod.	High	Mod.	Low	4-6	X	Native; wildlife; landscaping; erosion control
Japanese barberry (<i>Berberis thunbergii</i>)	3	Mod.	Long	Mod.	Low	Low	4-6	X	Thorny; scarlet fall foliage
Lilac (<i>Syringa vulgaris</i>)	10	Mod.	Long	Mod.	Mod.	Mod.	4-8		Windbreaks; landscape; erosion control
Pomegranate (<i>Punica granatum</i>)	12	Mod.	Mod.	Mod.	Low	Low	7-9	X	Windbreaks; wildlife, erosion control; fruit
Purpleosier willow (<i>Salix purpurea</i>)	10	Fast	Mod.	High	High	Mod.	4-6	X	Streambanks, erosion con- trol; hedges

(Table 3 continued)

DECIDUOUS SHRUBS

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Redosier dogwood (<i>Cornus sericea</i>)	15	Fast	Long	Mod.	High	Low	4-6	X	Native; hedges; wildlife; wind- breaks; stream- banks
Rose, baldhip (<i>Rosa gymnocarpa</i>)	4	Mod.	Mod.	Mod.	Mod.	Low	4-7	X	Wildlife; hedgerows; erosion control; landscaping
Rose, Woods ^m (<i>Rosa woodsii</i>)	4	Mod.	Mod.	Mod.	Mod.	Low	4-7	X	Native; wildlife; erosion control; low maintenance landscaping
Rubber rabbitbrush ^m (<i>Chrysothamnus nauseosus</i>)	6	Fast	Mod.	Low	Mod.	High	4-6		Native; erosion control; low maintenance landscaping
Saskatoon serviceberry ^m (<i>Amelanchier alnifolia</i>)	12	Mod.	Long	Mod.	Mod.	Low	4-6	X	Native; wildlife; windbreaks; erosion control; fruit
Shrubby cinquefoil (<i>Pentaphylloides floribunda</i>)	4	Fast	Long	Mod.	High	Mod.	4-6		Native; erosion control; land- scaping
Siberian peashrub ^m (<i>Caragana arborescens</i>)	10	Fast	Mod.	Low	Mod.	Mod.	4-6		Drought tolerant; windbreaks; erosion control
Silver buffaloberry ^m (<i>Shepherdia argentea</i>)	15	Mod.	Long	Mod.	Mod.	High	4-6	X	Native; wildlife; windbreaks; streambanks; fruit
Skunkbush sumac (<i>Rhus trilobata</i>)	8	Mod.	Mod.	Low	Mod.	Mod.	4-6	X	Native; wind- breaks; wildlife

(Table 3 continued)

DECIDUOUS SHRUBS

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Southernwood ^m (<i>Artemisia abrotanum</i>)	6	Mod.	Short	Mod.	Mod.	Mod.	4-8		Erosion control; windbreaks
Western sandcherry (<i>Prunus pumila besseyi</i>)	3	Mod.	Long	Low	Low	Low	5-6	X	Windbreaks; fruit for jelly; good wildlife plant; erosion control; spreads by suckers

EVERGREEN SHRUBS

Apacheplume (<i>Fallugia paradoxa</i>)	5	Mod.	Mod.	Low	Low	Mod.	6-9	X	Native; erosion control; low maintenance; landscaping
Big sagebrush ^m (<i>Artemisia tridentata</i>)	5	Mod.	Long	Low	Mod.	Mod.	4-6	X	Native; low maintenance; landscaping; erosion control
Bottlebrush (<i>Callistemon viminalis</i>)	20	Fast	Mod.	Mod.	Low	Mod.	8-9		Landscaping; ornamental
Cliffrose ^m (<i>Cowania stansburiana</i>)	8	Mod.	Mod.	Low	Mod.	Low	4-6	X	Native; erosion control; wildlife
Coyote willow ^m (<i>Salix exigua</i>)	8	Fast	Mod.	High	High	Mod.	4-6	X	Native; stream- banks; wildlife; erosion control
Creosotebush ^m (<i>Larrea tridentata</i>)	8	Mod.	Mod.	Low	Mod.	Low	4-6	X	Native; low maintenance; landscaping; cover on critical areas; ornamental

(Table 3 continued)

EVERGREEN SHRUBS

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Desertholly (<i>Atriplex hymenelytra</i>)	2	Mod.	Mod.	Low	Low	Mod.	7-9		Native; low maintenance; landscaping; ornamental; silver leaves
Ephedra ^m (<i>Ephedra</i> spp.)	5	Mod.	Long	Low	Mod.	Low	5-9		Native; attractive shrub for erosion control; low maintenance; landscaping. Must be planted densely.
Juniper (shrub forms) (<i>Juniperus</i> spp.)	11-12	Mod.	Long	Mod.	Mod.	Mod.	4-9	X	Numerous horticultural varieties; erosion control; landscaping
Oleander (<i>Nerium oleander</i>)	12	Fast	Long	Mod.	Mod.	Mod.	7-9		Windbreaks; erosion control; screens; poisonous if eaten
Pyracantha (<i>Pyracantha coccinea</i>)	8	Fast	Long	Mod.	Mod.	Mod.	5b-9	X	Landscaping; barriers; windbreaks; erosion control
White brittlebush (<i>Encelia farinosa</i>)	3	Fast	Mod.	Low	Mod.	Low	7-9		Native; erosion control; ornamental; low maintenance

(Table 3 continued)

GROUND COVER PLANTS

Species	Approximate ¹ height - (feet)	Growth rate	Longevity	Water requirements	Water table ² tolerance	Salt and alkali tolerance	Hardiness zone adaptation ³	Wildlife food	Remarks
Bearberry (<i>Arctostaphylos uva-ursi</i>)	1	Mod.	Mod.	Mod.	Low	Low	4-6	X	Native; bank cover; erosion control; landscaping; woody
Common periwinkle (<i>Vinca minor</i>)	1/2	Mod.	Mod.	High	Mod.	Low	4-6		Tolerates shade
Dusty miller (<i>Artemisia stelleriana</i>)	3	Fast	Mod.	Low	Mod.	Mod.	4-9		Fast spreading; erosion control; bank cover; fire resistant; semi- woody
Squawcarpet ^m (<i>Ceanothus prostratus</i>)	1	Slow	Long	Low	Mod.	Low	5a-7	X	Native; bank cover; granitic soils; woody
Teaberry (<i>Gaultheria shallon</i>)	2	Mod.	Mod.	Low	Low	Low	5b-7	X	Grows on poor acid soil; bank cover; prefers acid soil
White bursage (<i>Ambrosia dumosa</i>)	3	Slow	Mod.	Low	Low	Mod.	6-9		Native; low maintenance; landscaping; erosion control
Wooly yarrow (<i>Achillea tomentosa</i>)	1/2	Fast	Mod.	Low	Mod.	Mod.	4-8		Low foliage; fire resistant; erosion control; herbaceous

¹ Mature height under optimum soil and moisture conditions.

² Based on fluctuating water and poorly or somewhat poorly drained soils. Trees and shrubs usually not adapted to very poorly drained soils.

³ See plant hardiness zone map page ii. Zone indicates areas where plants are normally adapted.

⁴ ^m = Mined-land reclamation. Certain species are so designated although these and others may become more or less important for different environments.

WILDLIFE PLANTINGS

Any ranch or rangeland area can have natural or designed wildlife values. Changes in vegetative cover and management practices may have adverse effects on some wildlife species while benefiting others. Habitat for specific kinds of wildlife can often be improved by introducing new plant species or management techniques. Occasionally, as in game preserves and bird sanctuaries, wildlife habitat is the primary concern. If so, specialized facilities and techniques are required. More often, however, wildlife is only one of several factors landowners and managers must consider. This section is primarily directed to owners and managers interested in wildlife as a secondary consideration.

Planting, treating, and harvesting practices on croplands can be designed with consideration for wildlife. Rangelands can be developed or used intensively for other purposes without destroying wildlife habitat if wildlife needs are considered in planning and management. Many of the odd-shaped and little-used areas of ranches can be developed easily to provide good habitat for desirable wildlife species. Grazing management is essential.

Wildlife habitat requires a combination of food, cover, and water that provides an environment where the species can survive and reproduce. Food requirements vary with species, but a variety of food plants are essential to meet year-round needs. Browse plants provide most of the diet of deer, especially in the winter. Big game animals also consume forbs and grasses in varying quantities, especially during the spring. Game and song birds require insects or seeds and other parts of grasses, forbs, and woody plants. They also need cover for nesting, roosting and escape. Water is essential.

The following recommendations serve as guides to planning and managing agricultural and rangelands. More specific instructions and assistance can be obtained from the Nevada Department of Wildlife, the U. S. Fish and Wildlife Service, the Soil Conservation Service or University of Nevada Cooperative Extension.

Wildlife Management Techniques for Cropland Areas, Hedgerows, Fencerows, and Field Borders

1. Strips of unharvested grain or corn several yards wide around the edges of fields provide valuable feed for wildlife. Turnaround strips on row cropland and odd-shaped areas that receive water make excellent food and cover areas if left undisturbed. These should be adjacent to good, permanent cover. Long contact zones between food and cover are best. A food strip 20 feet wide by 500 feet long, bordering a fencerow, is much more effective than a 100- by 100-foot square in a corner of a field.

2. Plants listed in Table 2 for windbreaks or the tall grasses listed in Table 3 can be used for hedgerows, or along fencerows or ditchbanks, to improve or create wildlife habitat. Priority should be given to plants that produce seed or fruit.

3. Ditchbanks and fencerows should be left unburned and ungrazed through the winter. Limit the use of herbicides accordingly.

4. Unburned and ungrazed waste areas make excellent food, cover, and nesting areas.

5. Disking irrigated waste water areas, particularly those with poor drainage, permits food and cover plants to grow. Disk four rows initially and two alternate rows each year thereafter. Successional differences provide different plant species in the 1- and 2-year-old disked strips.

6. An uncut strip of hay or grain around the outer edge of a field is a valuable investment for wildlife.

7. Stubble fields left unplowed through the winter furnish valuable winter feed and cover.

8. Water must be available whenever wildlife use an area. This may require storing water or operating water facilities during times when it would otherwise be unnecessary. Design assistance is available from the Soil Conservation Service.

9. Using standard farming practices, short-stemmed varieties of fall and spring barley and winter wheat can be grown for green feed or grain.

10. Windbreaks with two or three rows of trees provide good cover and nesting habitat for a variety of song birds and other small wildlife species.

11. Hedgerows with different sizes of perennial grasses and/or shrubs enhance diversity of wildlife habitat.

Wet Areas

Methods of improving wetland habitat for wildlife include:

Riparian areas along streams or rivers can usually provide habitat that contrasts markedly from the surrounding landscape. Management of grazing and other land uses can often dramatically increase wildlife habitat. Examples of planned effects include: revegetation of trees (aspen, cottonwood, etc.) and shrubs (especially willow), improved rodent habitat in a meadow, and improved fish habitat in the stream.

1. Manage grazing to control thick stands of sedges, rushes, and shrubs. This should provide open spaces for birds, but leave enough clumps to provide feed and cover. Don't allow grazing during the nesting period of May and June.

2. Restrict controlled burning to the winter and fall to avoid interference with cover and nesting requirements in the spring. Some species select nest or den sites early in the spring. Burning may be necessary once every five to seven years.

3. If shallow pond areas are desired, positive water control will allow periodic drying for weed control.

4. Annual Japanese and Proso millets and perennial saltmarsh bulrush can be planted for food on areas that can be cultivated during dry periods.

Wildlife Management Techniques for Rangeland

Rangeland improvements and modifications can benefit wildlife. Some are:

1. Watering facilities should be equipped with

safety features to prevent wildlife from drowning. Watering facilities should be used to furnish water for wildlife after livestock are removed. Guzzlers and other water-catching and storing structures can be constructed to expand wildlife habitat into limited water areas or to provide water for a longer period.

2. Fenced livestock enclosures near water developments can provide suitable vegetative cover for birds and small animals.

3. Strips or pockets of native vegetation should be left in areas to be revegetated or where brush is to be reduced. Rough areas, ravines or riparian corridors are ideal for this purpose. Adequate consideration must be given to big game travel corridors.

4. Browse, seed or other food-producing plants (bitterbrush, ephedra, small burnet, fourwing saltbrush, and winterfat) can be included in the seeding mixture if the grazing management system will ensure establishment and maintenance of the stand.

5. Livestock grazing systems and fences should be compatible with wildlife needs. Grazing management can provide habitat benefits to wildlife and livestock.

Wildlife Considerations for Highways, Recreation, and Rest Sites

The presence of wildlife on highways is a serious hazard, however, birds and animals are desirable attractions in recreation and rest areas near highways. Wildlife needs must be considered in the project planning and design stages. In many cases, roadsides, recreational areas, rest areas, and highway rights-of-way may significantly improve wildlife habitat. Some possibilities are:

1. Tall, native perennial grasses planted on rural roadsides provide good nesting cover and shelter for small game. Use plant materials with low wildlife preference in hazardous areas.

2. Consider migration routes, nesting areas, and other key wildlife requirements when planning roads, campgrounds and other developments.

Underpasses, properly located with wing fences to guide big game, may be necessary to prevent blocking migration routes that cross major highways.

3. Provide vegetative cover strips as wildlife escape routes from water facilities and congested areas.

4. Water facilities should be safe for birds and other animals. Water must not attract animals into unsafe areas.

5. Seeded or natural nesting areas should not be mowed until after the nesting and brooding season, usually July 1.

6. Road surfaces can sometimes be used to collect water for distribution to wildlife or recreation areas away from the highway. Borrow pits can also be used as watering facilities for wildlife.

CONSERVATION COVER PLANTINGS

Conservation cover plantings are used in a variety of areas including road cuts and fills, borrow areas, spoilbanks, waterways, dams, ditchbanks, recreation sites, and roadside rest areas. These plantings frequently have important aesthetic values.

Most conservation cover plantings are on critical areas created by complete or partial alteration of the site. For this reason, soil survey data based on natural soil profiles are not always adequate. Most exposed soil material is from the subsoil or substrata and may be distinctly inferior to the natural soil of the area. Onsite investigation and special preparation are necessary for reasonable ensurance of successful plantings.

Critical-Area Planting Guide

It is important to establish vegetation on roadsides, dams, borrow pits, ditchbanks and areas disturbed by construction. Vegetative cover can protect the area from erosion, improve appearance and help control noxious weeds. Fire-resistant and low fuel volume plants aid fire prevention. For best results, make plantings as soon as possible after construction is completed.

Planning -- The first step in the installation of a critical-area planting is to develop a specific site plan. The conditions that exist will dictate the specific treatments needed. Whenever possible, the plan should be made before the construction begins. Items for consideration:

1. Type of structural work needed (diversions, benching, terracing, chute drop, or other water

disposal structures, retaining walls, etc.)

2. Need for and method of seedbed preparation.

3. Need for fertilizers and/or soil amendments.

4. Type of seed and plants to be used.

5. Seeding or planting procedures and planting dates.

6. Type of mulch to be used, how to apply and anchor.

7. Whether the planting will be irrigated, source of water, irrigation method, whether the irrigation system is permanent or for establishment only.

8. Plan for livestock exclusion if necessary. All sites should be protected from livestock until plantings are well established. Many plantings need permanent protection.

9. Determine maintenance needs and develop a maintenance plan.

Site Preparation -- Site preparation depends on the condition of the area and the plants to be used -- herbaceous, woody, or a combination of both. Most plantings should include grasses for initial ground cover even if woody plant cover is the end objective. Steps in site preparation are:

1. Smooth and shape the area and remove any stumps, large rocks, or debris left by construction.

2. Shape banks to slopes no steeper than 3-to-1. Where this is not feasible, it may be necessary to install retaining walls at the toe of the slope to control sloughing.

3. Install diversions, terraces, drop chutes or other structures needed for water control.

4. Loosen or scarify compacted areas. Perform these operations across the slope as nearly on the contour as possible.

5. If topsoil is available, apply 2 to 4 inches after scarification. Stockpiling topsoil should be included in construction plans. Replaced topsoil provides a better medium for plant establishment and growth. It may contain native seed or plant parts (rhizomes, roots, sprigs) that will grow and aid in establishing plant cover. Replacing topsoil may be the most effective and practical way to establish vegetation in arid desert areas.

6. Arid desert areas almost always are low in fertility and need fertilizer. Fertilizer needs can be determined by soil tests. A minimum of 40-80 pounds of nitrogen and 50-100 pounds of phosphate per acre is usually needed. Some additional nitrogen may be needed the first year or two after planting. Other soil amendments, such as gypsum or sulfur, may be needed on highly alkaline sites. Lime may be needed on acid mine spoils or tailings. Fertilizer and soil amendments should be applied and worked into the soil surface before planting. However, fertilizing without irrigating arid or semiarid sites may enhance competition from early season weeds such as cheatgrass. Fertilization without irrigation may decrease establishment.

Planting -- Use plant species and varieties adapted to the area. Grasses, legumes, and other herbaceous plants provide the best ground cover and erosion control, but shrubs and trees may be needed for the final vegetative cover. Use native plants whenever possible. Select adapted plants from Tables 1, 3 and 4. The plants listed for rangeland plantings can also be used for critical-area plantings where adapted. Tables 1, 3 and 4 indicated species that have special potential for mine waste reclamation and species

adapted to the warmer day and nighttime temperatures found in southern Nevada.

There are a number of native wildflower species that can be added to critical-area plantings to enhance their aesthetic values. Seeds may be available from specialized seed dealers or can be collected from natural stands. A small amount of wildflower seed added to a planting may significantly improve the site's appearance. Plants with potential for this use are: beeplant (*Cleome* spp.), gaillardia (*Gaillardia* spp.), brittlebush (*Encelia* spp.), butterweed (*Senecio serra*), California poppy (*Eschscholzia* spp.), desert marigold (*Baileya* spp.), Fremont dalea (*Dalea fremontii*), globemallow (*Sphaeralcea* spp.), lupine (*Lupinus* spp.), phacelia (*Phacelia* spp.), purple sage (*Salvia dorrii carnosa*), blackeyed coneflower (*Rudbeckia hirta*), and fleabane (*Erigeron* spp.). For some species it may be better to start plants in containers and transplant them instead of seeding directly on site.

1. Use a drill for seeding on sites where normal farm equipment can be operated. Steep slopes can be seeded by broadcasting or with a hydroseeder. On sites to be broadcast or hydroseeded, the surface should be slightly roughened with pockets or grooves and furrows across the slope to trap and hold the seed. Seeding rates should be double that used for drill seeding.

2. Trees, shrubs, grasses and legumes are usually hand planted. Mechanical tree planters can be used on suitable sites.

Bareroot or potted plants can be used, but potted plants have a better chance of surviving. This is especially true of evergreen species. Bareroot plants should always be dormant when planted.

Slow-release fertilizers can be placed in the planting hole. Be sure the hole is large and deep enough to accept the plant without bending or curling the roots. Tamp the soil firmly around the plant to seal out any air pockets. Water the plants immediately after planting unless ample soil moisture is present.

Plants should be placed in a random arrangement, not in rows. Plants can be placed in rows across the slope if they are staggered and do not form rows up and down the slope. If several species are used, it is usually best to mix them instead of planting them in blocks of single species. This, of course, is not true where one species is adapted only to a wet section of the area and another only to the dry section.

3. Quick cover can be established by using commercially produced sod. Many species and varieties are available from regional or local sod farms. Selection should depend on site, use and maintenance considerations.

Site preparation for sod should be the same as for seeding. Some additional smoothing and packaging may be required to remove irregularities that interfere with sod placement.

Lay sod strips across the slope, never up and down. Start at the bottom of the slope and work upward. On steep slopes, ladders will facilitate the work. Place the sod strips so the joints are snug and even. Stagger the joints across the slope.

Roll or tamp the sod immediately after placement to ensure solid contact of the root mat and soil surface. On sloping sites, secure the sod to the soil

with wire staples or wooden pegs. Water thoroughly after placement. Continue watering as needed to maintain optimum moisture for two weeks, then water as needed to maintain growth.

Mulching -- Mulching is desirable on all seeded sites and is essential on any slope of 3-to-1 or steeper. Mulching should be considered for all critical-area plantings, both herbaceous and woody. Mulch aids in plant establishment and protects the area from erosion until plant cover is established.

Well anchored straw or hay mulch lasts for several seasons and helps establish volunteer native plants and seeded species. A good mulching job may be the single most important practice in the vegetative treatment of critical areas.

Straw or hay at 1-1/2 to 2 tons per acre is the best mulching material for plant establishment. It can be applied by hand or with a straw blower or spreader. Hay or straw mulch must be mechanically anchored with a mulch anchoring machine or with twine, netting, or a sticking compound. Wood fibers, wood chips, rock, gravel, jute matting or other commercial mulching materials can be used. If hydromulching is used, it should be a separate operation performed after seeding.

TABLE 4
Adaptation and Characteristics of Plants for Conservation Cover on Critical Areas

GRASSES

Species	Recommended varieties	Growth form	Minimum rainfall needs (inches)	Tolerance to prolonged wetness	Salt and alkali tolerance	PLS ¹ seeding rate lb./acre	Remarks
Alkali sacaton (<i>Sporobolus airoides</i>)	Salado Saltalk	Bunch	6-8	High	High	4	Native; warm-season; needs summer moisture; difficult to establish
Bermudagrass (<i>Cynodon dactylon</i>)	Coastal NK-37	Sod	16	High	High	4	Best established by sprigging; adapted in southern Nevada; usually need to be irrigated
Bluegrass Canby (<i>Poa sandbergii</i>)	Ranger Canbar	Bunch	8-10	Low	Mod.	5	Native; early spring grower; not highly productive
Bottlebrush squirreltail ^{m2} (<i>Elymus elymoides</i>)	--	Bunch	6-10	Low	Mod.	12	Very drought tolerant; collect seed from native stands
Creeping meadow foxtail (<i>Alopecurus arundinaceus</i>)	Garrison	Sod	16	High	Mod.	8	Good on streambanks and wet sites
Hard fescue (<i>Festuca trachyphylla</i>)	Durar	Bunch	12-14	Low	Low	8	Heavy root producer; low palatability; withstands traffic
Indian ricegrass ^m (<i>Oryzopsis hymenoides</i>)	Paloma Nezpar	Bunch	6-10	Low	Mod.	12	Native; well adapted to sands and sandy soils
Inland saltgrass (<i>Distichlis stricta</i>)	--	Sod	8-10	High	High	-	Native; establish by sprigging; needs irrigation for establishment

(Table 4 continued)

GRASSES

Species	Recommended varieties	Growth form	Minimum rainfall needs (inches)	Tolerance to prolonged wetness	Salt and alkali tolerance	PLS ¹ seeding rate lb./acre	Remarks
Mammoth wildrye ^m (<i>Elymus giganteus</i>)	Volga	Sod	8-10	Mod.	Mod.		Establish by sprigging; good for sand dune stabilization
Perennial ryegrass (<i>Lolium perenne</i>)	Linn Manhattan	Bunch	16	Mod.	Mod.	16	Good seedling vigor; establishment for quick cover; often short-lived
Reed canarygrass (<i>Phalaris arundinacea</i>)	Rise	Sod	16	High	Mod.	10	Good on stream-banks and wet sites; can be established by sprigging
Sand dropseed (<i>Sporobolus cryptandrus</i>)	--	Bunch	8-10	Low	Low	2	Native; adapted to sandy soils; reseeds readily
Smooth brome ^m (<i>Bromus inermis</i>)	Lincoln Manchar	Sod	12-14	Mod.	Mod.	16	Lincoln variety preferred; Manchar forms a weaker sod
Tall fescue (<i>Festuca arundinacea</i>)	Kenmont Alta Goars	Bunch	16	Mod.	Mod.	16	Goar variety used in southern Nevada; usually needs some irrigation
Wheatgrass, crested ^m (<i>Agropyron cristatum</i>)	Fairway Hycrest Ephraim	Bunch	8-10	Low	Mod.	12	Very drought tolerant; not well adapted in southern Nevada
Wheatgrass, desert ^m (<i>Agropyron desertorum</i>)	Nordan	Bunch	8-10	Low	Mod.	12	Good seedling vigor; drought tolerant as Fairway

(Table 4 continued)

GRASSES

Species	Recommended varieties	Growth form	Minimum rainfall needs (inches)	Tolerance to prolonged wetness	Salt and alkali tolerance	PLS ¹ seeding rate lb./acre	Remarks
Wheatgrass, intermediate ^m (<i>Elytrigia intermedia</i>)	Tegmar Amur Oahe	Sod	10-12	Low	Low	16	Good seedling vigor; good critical-area plant
Wheatgrass, pubescent ^m (<i>Elytrigia intermedia</i>)	Luna Topar	Sod	10-12	Low	Low	16	Good seedling vigor; moderate sod; high palatability
Wheatgrass, Siberian ^m (<i>Agropyron fragile</i> ssp. <i>sibiricum</i>)	P-27	Bunch	8-10	Low	Mod.	12	Similar to desert wheatgrass, but slightly more drought tolerant
Wheatgrass, streambank (<i>Elymus lanceolatus</i> ssp. <i>lanceolatus</i>)	Sodar	Sod	8-10	Low	Mod.	20	Moderate sod; low platability; few seed stalks produced
Wheatgrass, tall (<i>Elytrigia elongata</i>)	Jose Alkar	Bunch	12-14	High	High	20	Coarse and tall; can be used as wind buffers; broad soil adaptation
Wheatgrass, thickspike (<i>Elymus lanceolatus</i> ssp. <i>lanceolatus</i>)	Critana	Sod	10-14	Mod.	Mod.	16	Native; good seedling vigor; best adapted in northern Nevada
Wheatgrass, western (<i>Pascopyrum smithii</i>)	Rosana Arriba	Sod	10-12	High	High	16	Native; makes good sod; prefers fine-textured soils

FORBS - Usually Planted in Mixtures with Grasses

Australian saltbush ^m (<i>Atriplex semibaccata</i>)	Conto	Bunch	8-10	Mod.	Low	10	Adapted in southern Nevada; very drought tolerant once established
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(Table 4 continued)

FORBS

Species	Recommended varieties	Growth form	Minimum rainfall needs (inches)	Tolerance to prolonged wetness	Salt and alkali tolerance	PLS ¹ seeding rate lb./acre	Remarks
Lewis flax ^m (<i>Linum lewisii</i>)	Appar	Bunch	12-14	Mod.	Low	10	Native; adds aesthetic value to plantings; good seedling vigor
Mountain pride penstemon ^m (<i>Penstemon newberryi</i>)	--	Bunch	12-14	Low	Low	5	Native; good seedling vigor; may be best to establish by transplants
Palmer penstemon ^m (<i>Penstemon palmeri</i>)	Cedar	Bunch	8-12	Low	Low	5	Native; good seedling vigor; established by direct seeding
Rocky Mountain penstemon (<i>Penstemon strictus</i>)	Bandera	Bunch	12-14	Mod.	Low	5	Native; good seedling vigor; established by transplants
Small burnet ^m (<i>Sanguisorba minor</i>)	Delar	Bunch	12-14	Low	Low	20	Valuable for livestock and wildlife; good seed producer
Sulfur eriogonum (<i>Eriogonum umbellatum</i>)	--	Bunch	10-12	Low	Mod.	8	Native; good seedling vigor; broadly adapted somewhat woody; yellow flowers

¹ PLS is pure live seed - see chart on page 10 on how to convert PLS to actual seeding rate. Rates are for single species seedings. For determining seeding rates for mixtures - see page 8.

² ^m = Mined-land reclamation. Certain species are so designated although these and others may become more or less important for different environments.

NOTE: All plants listed in Table 1 for rangeland plantings are also suited for critical-area plantings on adapted sites.

MINED-LAND RECLAMATION PLANNING

Planning is particularly important for mine reclamation. There are generally four stages of mining: (1) exploration, (2) development, (3) production, and (4) reclamation. A plan for mined-land reclamation must address each of these four stages and should include several important elements.

The first effort should be vigorous premining ecosystem inventory and mapping. The plan can include procedures for the removal and storage of topsoil, species selection, and revegetation. Mitigation for water and air quality must be addressed. The plan should summarize and carefully schedule all reclamation components.

To assure timeliness of reclamation, the plan should specify concurrent reclamation so the process can begin as the mine is developed and be well on its way to accomplishment by the time the mine is played out.

Following is a brief consideration of mine reclamation for people involved with environmental questions. Generally, previous sections of this report cover many of the problems that might be encountered in the rehabilitation of mine wastes. There are some important distinctions to consider. The National Academy of Sciences has defined three terms:

Reclamation: Process by which disturbed ecosystems are returned to conditions similar to the original or predisturbance ecosystems.

Rehabilitation: Construction of alternative ecosystems consistent with the existing land use that are ecologically stable, but that may differ substantially from native ecosystems.

Restoration: Re-creation of conditions identical to those that existed before disturbance.

Most common are reclamation and restoration. In most instances we are talking about either reclamation or rehabilitation. The cost of restoration is high and the necessity for it is low.

Plant adaptation and survival is determined by seedling establishment attributes, genetic variability, natural recruitment, compatibility, and resilience to

management practices. Mining usually destroys the soil profile. Physical, chemical, and biological characteristics are altered. Therefore, topsoil management is an important consideration. In many cases topsoil can be removed and replaced, allowing the land to be reclaimed by appropriate revegetation. Topsoiling is essential in achieving any degree of reclamation or rehabilitation. Often this requires reshaping and grading, followed by topsoil replacement, species and seed selection, followed by site preparation and planting.

Mulch, fertilizers and supplemental irrigation, e.g. drip systems, may be required for plant establishment. Fertilization is important where topsoil cannot be stockpiled and replaced, because the growth medium may be extremely low in important, but common, nutrients. Disturbed lands are usually deficient in nitrogen and phosphorus. They often require from 50 to 500 pounds per acre (R-4 Reclamation Field Guide, USDA Forest Service Ogden, Utah). Acid soils, acid waste materials, and acid drainage waters are problems on some mine waste areas and require special attention.

Revegetation requires careful seedbed preparation and species selection. Site-specific species selection is often critical for success (See Tables 1, 3 and 4). In most instances mixtures are used rather than single species are used for seeding. A typical reclamation seeding mix for many intermediate elevation sagebrush sites in northern Nevada may look like the following:

Species	Lbs/Acre
Nordan crested wheatgrass	4
Sodar streambank wheatgrass	9
Pubescent wheatgrass	9
Fourwing saltbush	2
Small burnet	1
Prostrate kochia	2
Total	27

Other areas of the state with different types of original vegetation would require different mixtures.

A mixture will do three things: increase the probability of seeding success; provide a diversity of species for rangeland use and wildlife habitat use; and provide improved soil protection.

It is important to protect young plants until they are fully established. Species that have proven useful for mined-land reclamation have been so designated in Tables 1, 3 and 4.

Monitoring will judge the success of revegetation. A successful revegetation effort includes:

1. Germination - seed is scarified and begins growth.

2. Emergence - seed expands and seedlings emerge from the soil.

3. Establishment - plants make it through the first growing season.

4. Survival - plants overwinter and make it through the second growing season.

Monitoring should include: ascertaining the success of revegetation; gathering information on air and water quality; and, successful use of reclaimed sites for forest forage, wildlife habitat, recreation or other multiple target uses.

APPENDIX 1

Key to Soils for Rangeland Plantings

To use this key, first check the list of conditions (below) that make a soil unsuitable for rangeland seedings. If the soil in question has none of these limiting properties, work stepwise through the key. Place the soil in the first suitability group it fits.

Some soils identified as unsuitable could be successfully seeded under some circumstances. Individual judgments must be made. Climate and inherent fertility are partly reflected in the groupings by soil properties, but separate consideration of these factors should be helpful in deciding borderline cases.

Guide to Unsuitable Soil Conditions

1. Soils that are salt or alkali-affected throughout the upper 20 inches¹.
2. Soils having surface cobbles or stones that prevent the use of available seeding equipment.
3. Soils on slopes greater than 30 percent.
4. Soils that have more than 7 inches of sand coarser than loamy fine sand at the surface, regardless of underlying texture, and that get less than 10 inches of annual precipitation. Seedings are quite difficult to establish on these soils without predictable summer rains.
5. Soils that are clay textured throughout, crack deeply from the surface on drying, and tend to spontaneously form a granular surface as summer progresses. (Vertisols²).
6. Soils with less than 10 inches of topsoil³ and an abrupt boundary to an underlying claypan, i.e., very clayey B2t horizon.
7. Soils less than 10 to 20 inches deep over clean gravel, hardpan, or bedrock, depending on the climate and water capacity of the soil.
8. Soils with light-colored topsoil that is commonly crusted between plants. The crust has

numerous bubble-like pores (vesicles). (Typic subgroups of the Aridisols⁴).

Guide to Suitable Soil Conditions

1. Very poorly and poorly drained soils⁵ that have dark topsoil more than 10 inches thick and are only somewhat salt affected (EC 10^3 less than 8; SAR less than 20) Group I
2. Somewhat poorly and moderately well drained soils that have textures other than sand, loamy sand or clay and are only somewhat salt affected (EC 10^3 less than 8, SAR less than 20) Group II
3. Well-drained soils.
 - a. Soils having a moderately light-textured topsoil in which the upper 1 to 2 inches are noticeably lighter than the lower few inches when the soil is dry. The soil may or may not be weakly crusted between plants and the crust may or may not be vesicular (xerollic subgroups of the Aridisols⁶) Group III
 - b. Soils having a moderately dark or dark topsoil that is equally dark throughout and is at least 7 or more inches thick (Mollisols⁷) Group IV

1. Soil salinity is measured by making a saturated paste of the soil, extracting the soil solution, and measuring the electrical conductivity of the extract. The unit of measurement is millimho per centimeter (mmho/cm), and the symbol "ECe x 10^3 ." The same, "salinity hazard," is commonly given for this measurement in laboratory reports. The salinity level allowable for rangeland seedings is higher than for many cultivated crops and is estimated at about an ECe x 10^3 or less than 8 mmhos/cm. The alkali or "sodium hazard" is determined from analysis of the

same saturated paste extract, and is given as a plain number, sometimes called the SAR value (sodium adsorption ratio). Values greater than about 25 are considered hazardous for rangeland seedings.

2. The names in parentheses refer to Soil Taxonomy, Agriculture Handbook 436, Soil Conservation Service, U.S. Department of Agriculture, 1975. Where soil surveys are available, the maps can be directly interpreted for rangeland seeding and many other purposes. This key is primarily an attempt to suggest soil properties useful for evaluations in the large areas of Nevada for which no soil maps exist.

3. In this key, "topsoil" means the A horizon.

4. Soils in typic subgroups of the Aridisols have Munsell color values for the mixed A horizon of >5.5 dry and >3.5 moist, and have an average organic carbon content of <0.58 percent. The Munsell color

system is a scientific method of identifying soil color properties -- value (light-dark), chroma (richness), and hue (kind). Identification is made by comparison to standard color chips. Organic carbon content is a measure of humus, or organic matter.

5. See Appendix 2.

6. The xerollic subgroups of the Aridisols have Munsell color values for the mixed A horizon of 5 to 6 dry and 3 to 4 moist. The average organic carbon content of the A horizon is intermediate between typic subgroups of Aridisols and Mollisols.

7. The Mollisols have Munsell color values for the mixed A horizon of <5.5 dry and <3.5 moist; the chroma of the A horizon should be <3.5 moist and average organic carbon content should be >0.58 percent.

APPENDIX 2

Field Evidence for Identifying Soil Drainage Classes

Class	Field Criteria
<u>Very poorly drained:</u>	Water table remains at the surface or within 20 inches of the surface most of the year. Surface horizons are commonly dark and peaty or mucky. Subsurface horizon colors are neutral grays, olive, or bluish gray, with or without dull mottling. Grazing possible at least seasonally. Hay can be harvested in drier years.
<u>Poorly drained:</u>	Soil very wet much of the time. Water table seasonally at or near surface for several weeks. Water table within 20 to 40 inches of the surface most of the year. Surface horizon commonly dark and prominent. Soluble salt accumulation may occur at or near surface. Subsurface horizon dull gray or olive, with or without mottling. Grazing possible most of the time. Hay usually can be harvested.
<u>Somewhat poorly drained:</u>	Soil seasonally very wet for several weeks because of an impermeable layer or a water table 40 to 60 inches below surface. Surface horizon commonly thick and dark and subsurface horizon dull gray and commonly mottled. Prominent soluble salt accumulation may occur in upper 40 inches. Drainage necessary for deep-rooted crops.
<u>Moderately well drained:</u>	Soil seasonally very wet for a week or so because of an impermeable layer or an intermittently high water table that is more than 60 inches below the surface most of the year, or because of surface flooding from adjacent areas. Surface horizon usually thicker and darker than adjacent well-drained soils. Indistinct mottling usually present in lower subsurface horizon.
<u>Well drained:</u>	Soil not very wet for more than a few days after protracted and heavy storms. No water table within 60 inches of surface at any time. Surface and subsurface horizons not gleyed or mottled, but yellowish, brownish, or reddish.
<u>Excessively drained:</u>	Soil moist for only a few days after storms. Soil porous throughout with no fine-textured or impermeable layers. Water does not run off surface except after intense storms. No water table within 60 inches of surface.
<u>Altered drainage:</u>	Soils that have been artificially drained, but retain the dark surface horizons, peaty or mucky surface horizon, or dull or mottled subsurface colors of former drainage status.

APPENDIX 3

Scientific and Common Plant Names

Scientific	Common
Grasses and Grasslike Plants	
<i>Agropyron cristatum</i>	Crested wheatgrass
<i>Agropyron cristatum</i> X <i>A. desertorum</i>	Crested wheatgrass hybrid
<i>Agropyron desertorum</i>	Desert wheatgrass
<i>Agropyron fragile</i> ssp. <i>sibiricum</i>	Siberian wheatgrass
(<i>Agropyron sibiricum</i>)	
<i>Agropyron inerme</i>	Beardless wheatgrass
<i>Alopecurus arundinaceus</i>	Creeping meadow foxtail
<i>Arundo donax</i>	Giant reed
<i>Bromus erectus</i>	Turkish brome
<i>Bromus inermis</i>	Smooth brome
<i>Bromus marginatus</i>	Mountain brome
<i>Bromus tectorum</i>	Cheatgrass
<i>Carex</i> spp.	Sedge
<i>Cynodon dactylon</i>	Bermudagrass
<i>Distichlis stricta</i>	Inland saltgrass
<i>Echinochloa crusgalli frumentacea</i>	Japanese millet
<i>Elymus elymoides</i>	Bottlebrush squirreltail
(<i>Sitanion hystrix</i>)	
<i>Elymus giganteus</i>	Mammoth wildrye
<i>Elymus lanceolatus</i> ssp. <i>lanceolatus</i>	Thickspike wheatgrass
(<i>Agropyron dasystachyum</i>)	
<i>Elymus lanceolatus</i> ssp. <i>lanceolatus</i>	Streambank wheatgrass
(<i>Agropyron riparium</i>)	
<i>Elymus trachycaulus</i> ssp. <i>trachycaulus</i>	Slender wheatgrass
(<i>Agropyron trachycaulum</i>)	
<i>Elytrigia elongata</i>	Tall wheatgrass
(<i>Agropyron elongatum</i>)	
<i>Elytrigia intermedia</i>	Intermediate wheatgrass
(<i>Agropyron intermedium</i>)	
<i>Elytrigia intermedia</i>	Pubescent wheatgrass
(<i>Agropyron trichophorum</i>)	
<i>Elytrigia repens</i> X <i>Pseudoroegneria spicata</i>	Hybrid wheatgrass
(<i>Agropyron repens</i> X <i>Agropyron spicata</i>)	
<i>Festuca arundinacea</i>	Tall fescue
<i>Festuca idahoensis</i>	Idaho fescue
<i>Festuca trachyphylla</i>	Hard fescue
(<i>Festuca ovina duriuscula</i>)	
<i>Hilaria jamesii</i>	Galleta
<i>Leymus cinereus</i>	Basin wildrye

(Appendix 3 continued)

Scientific	Common
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Grasses and Grasslike Plants (continued)

<i>Lolium perenne</i>	Perennial ryegrass
<i>Oryzopsis hymenoides</i>	Indian ricegrass
<i>Panicum miliaceum</i>	Proso millet
<i>Pascopyron smithii</i>	Western wheatgrass
(Agropyron smithii)	
<i>Phalaris arundinacea</i>	Reed canarygrass
<i>Phleum pratense</i>	Timothy
<i>Poa sandbergii</i>	Big bluegrass
(Poa ampla)	
<i>Poa sandbergii</i>	Canby bluegrass
(Poa canbyi)	
<i>Poa sandbergii</i>	Sandberg bluegrass
(Poa secunda)	
<i>Psathyrostachys juncea</i>	Russian wildrye
(Elymus junceus)	
<i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>	Bluebunch wheatgrass
(Agropyron spicatum)	
<i>Scirpus robustus</i>	Saltmarsh bulrush
<i>Sporobolus airoides</i>	Alkali sacaton
<i>Sporobolus cryptandrus</i>	Sand dropseed
<i>Stipa thurberiana</i>	Thurber needlegrass

Forbs

<i>Achillea tomentosa</i>	Wooly yarrow
<i>Artemisia stellerana</i>	Dusty miller
<i>Astragalus cicer</i>	Cider milkvetch
<i>Atriplex semibaccata</i>	Australian saltbush
<i>Baileya</i> spp.	Desert marigold
<i>Cleome</i> spp.	Beeplant
<i>Eriogonum umbellatum</i>	Sulfur buckwheat
<i>Erigeron</i> spp.	Fleabane
<i>Eschscholzia</i> spp.	California poppy
<i>Gaillardia</i> spp.	Gaillardia
<i>Kochia prostrata</i>	Prostrate kochia
<i>Lathyrus sylvestris</i>	Flatpea
<i>Linum lewisii</i>	Lewis flax
<i>Lotus corniculatus</i>	Birdsfoot trefoil
<i>Lupinus</i> spp.	Lupine
<i>Medicago sativa</i>	Alfalfa
<i>Melilotus officinalis</i>	Yellow sweetclover
<i>Onobrychis viciifolia</i>	Sainfoin
<i>Penstemon newberryi</i>	Mountain pride penstemon
<i>Penstemon palmeri</i>	Palmer penstemon
<i>Penstemon strictus</i>	Rocky Mountain penstemon

(Appendix 3 continued)

Scientific	Common
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Forbs (continued)

<i>Petalostemum purpureus</i>	Purple prairieclover
<i>Phacelia</i> spp.	Phacelia
<i>Rudbeckia hirta</i>	Blackeyed coneflower
<i>Sanguisorba minor</i>	Small burnet
<i>Senecio jerra</i>	Butterweed
<i>Sphaeralcea</i> spp.	Globemallow
<i>Vinca minor</i>	Common periwinkle

Shrubs

<i>Ambrosia dumosa</i>	White bursage
(<i>Franseria dumosa</i>)	
<i>Amelanchier alnifolia</i>	Saskatoon serviceberry
<i>Arctostaphylos uva-ursi</i>	Bearberry
<i>Artemisia abrotanum</i>	Southernwood
<i>Artemisia tridentata</i>	Big sagebrush
<i>Atriplex canescens</i>	Fourwing saltbush
<i>Atriplex confertifolia</i>	Shadscale
<i>Atriplex hymenelytra</i>	Desertholly
<i>Atriplex lentiformis</i>	Big saltbush
<i>Berberis thunbergii</i>	Japanese barberry
<i>Callistemon viminalis</i>	Bottlebrush
<i>Caragana arborescens</i>	Siberian peashrub
<i>Ceanothus prostratus</i>	Squawcarpet
<i>Ceratoides lanata</i>	Winterfat
(<i>Eurotia lanata</i>)	
<i>Ceratoides lantens</i>	Pamir winterfat
<i>Chilopsis linearis</i>	Desert willow
<i>Chrysothamnus nauseosus</i>	Rubber rabbitbrush
<i>Colutea arborescens</i>	Bladdersenna
<i>Cornus sericea</i>	Redosier dogwood
(<i>Cornus stolonifera</i>)	
<i>Cotoneaster acutifolius</i>	Peking cotoneaster
<i>Cotoneaster microphyllus</i>	Rockspray cotoneaster
<i>Cowania stansburiana</i>	Cliffrose
<i>Dalea fremontii</i>	Fremont dalea
<i>Encelia farinosa</i>	White brittlebush
<i>Ephedra</i> spp.	Ephedra
<i>Fallugia paradoxa</i>	Apacheplume
<i>Forsythia</i>	Forsythia
<i>Gaultheria shallon</i>	Teaberry
<i>Juniperus</i> spp.	Juniper spp.
<i>Larrea tridentata</i>	Creosotebush
(<i>Larrea divaricata</i>)	
<i>Ligustrum amurense</i>	Amur privit

(Appendix 3 continued)

Shrubs (continued)

Scientific	Common
<i>Lonicera involucrata</i>	Twinberry honeysuckle
<i>Lonicera tatarica</i>	Tatarian honeysuckle
<i>Nerium oleander</i>	Oleander
<i>Pentaphylloides floribunda</i>	Shrubby cinquefoil
(<i>Potentilla fruticosa</i>)	
<i>Prunus americana</i>	American plum
<i>Prunus pumila besseyi</i>	Sandcherry
<i>Prunus triloba</i>	Flowering almond
<i>Punica granatum</i>	Pomegranate
<i>Purshia tridentata</i>	Antelope bitterbrush
<i>Pyracantha coccinea</i>	Pyracantha
<i>Rhus trilobata</i>	Skunkbush sumac
<i>Ribes aureum</i>	Golden currant
<i>Ribes cereum</i>	Wax currant
<i>Rosa gymnocarpa</i>	Baldhip rose
<i>Rosa woodsii</i>	Woods rose
<i>Salix exigua</i>	Coyote willow
(<i>Salix interior</i>)	
<i>Salix purpurea</i>	Purpleosier willow
<i>Salvia dorrii carnosa</i>	Purple sage
<i>Sambucus caerulea</i>	Blue elderberry
<i>Shepherdia argentea</i>	Buffaloberry, silver
<i>Symphoricarpos albus</i>	Common snowberry
<i>Syringa vulgaris</i>	Lilac

Trees

<i>Acer ginnala</i>	Amur maple
<i>Acer platanoides</i>	Norway maple
<i>Ailanthus altissima</i>	Tree-of-heaven
<i>Alnus incana</i> ssp. <i>tenuifolia</i>	Thinleaf alder
(<i>Alnus tenuifolia</i>)	
<i>Celtis occidentalis</i>	Hackberry
<i>Celtis laevigata</i> var. <i>reticulata</i>	Netleaf hackberry
(<i>Celtis reticulata</i>)	
<i>Cercis canadensis</i>	Eastern rosebud
<i>Crataegus phaenopyrum</i>	Washington hawthorn
<i>Cupressus arizonica</i>	Arizona cypress
<i>Cupressus sempervirens</i>	Italian cypress
<i>Elaeagnus angustifolia</i>	Russian olive
<i>Eucalyptus globulus</i>	Bluegum eucalyptus
<i>Eucalyptus viminalis</i>	Whitegum eucalyptus
<i>Fraxinus pennsylvanica</i>	Green ash
<i>Fraxinus velutina</i>	Arizona ash
<i>Ginkgo biloba</i>	Ginkgo
<i>Gleditsia triacanthos</i>	Honeylocust
<i>Juniperus scopulorum</i>	Rocky Mountain juniper

(Appendix 3 continued)

Scientific	Common
Trees (continued)	
<i>Malus baccata mandshurica</i>	Manchurian crabapple
<i>Malus pumila</i>	Flowering crabapple
<i>Morus alba sibirica</i>	Fruitless mulberry
<i>Parkinsonia florida</i>	Blue paloverde
(Ceridium floridum)	
<i>Picea abies</i>	Norway spruce
<i>Picea engelmannii</i>	Engelmann spruce
<i>Picea pungens</i>	Colorado blue spruce
<i>Pinus brutia eldarica</i>	Afghanistan pine
<i>Pinus halepensis</i>	Aleppo pine
<i>Pinus jeffreyi</i>	Jeffrey pine
<i>Pinus monophylla</i>	Singleleaf pinyon pine
<i>Pinus nigra</i>	Austrian pine
<i>Pinus ponderosa</i>	Ponderosa pine
<i>Pinus sylvestris</i>	Scotch pine
<i>Pinus thunbergii</i>	Japanese black pine
<i>Platanus occidentalis</i>	American sycamore
<i>Platanus racemosa</i>	California sycamore
<i>Platyclusus orientalis</i>	Arborvitae
(Thuja orientalis)	
<i>Populus alba boleana</i>	Boleana poplar
<i>Populus deltoides</i>	Siouxland poplar
<i>Populus fremontii</i>	Fremont cottonwood
<i>Populus nigra</i>	Lombardy poplar
<i>Populus robusta</i>	Robusta poplar
<i>Populus X (Hybrid 1-H-78-D)</i>	Italian hybrid poplar
<i>Prunus virginiana</i>	Common chokecherry
<i>Quercus macrocarpa</i>	Bur oak
<i>Robinia psuedoacacia</i>	Black locust
<i>Salix alba var. vitellina</i>	Golden willow
<i>Salix pentandra</i>	Laurel willow
<i>Sequoiadendron giganteum</i>	Giant sequoia
<i>Tamarix aphylla</i>	Athel
<i>Ulmus americana</i>	American elm
<i>Ulmus pumila</i>	Siberian elm
<i>Yucca brevifolia</i>	Joshua tree

APPENDIX 4

Recommended Varieties

Grasses

Alkali sacaton -- Salado, Saltalk
Basin wildrye -- Trailhead, Magnar
Beardless wheatgrass -- Whitmar
Bermudagrass -- Coastal, NK-37
Big bluegrass -- Sherman
Bluebunch wheatgrass -- Goldar
Canby bluegrass -- Ranger, Canbar
Creeping meadow foxtail -- Garrison
Crested wheatgrass -- Fairway, Ephraim
Crested wheatgrass hybrid -- Hycrest
Desert wheatgrass -- Nordan
Galleta -- Viva
Hard fescue -- Durar
Hybrid wheatgrass -- Newwhy
Idaho fescue -- Nezper
Indian ricegrass -- Nezpar, Paloma
Inland saltgrass *
Intermediate wheatgrass -- Amur, Oahe, Tegmar
Mammoth wildrye -- Volga
Mountain brome -- Bromar
Perennial ryegrass -- Linn, Manhattan
Pubescent wheatgrass -- Luna, Topar
Reed canarygrass -- Rise
Russian wildrye -- Bozoi-sky-select, Vinall
Sand dropseed *
Siberian wheatgrass -- P27
Slender wheatgrass -- Primar

Bottlebrush squirreltail *
Streambank wheatgrass -- Sodar
Tall fescue -- Kenmont, Alta, Goars
Tall wheatgrass -- Jose, Alkar
Thickspike wheatgrass -- Critana
Turkish brome -- Regar
Western wheatgrass -- Rosana, Arriba

Legumes

Alfalfa -- Ladak 65
Cicer milkvetch -- Lutana
Flatpea -- Lathco
Purple prairieclover -- Kaneb
Sainfoin -- Remont
Yellow sweetclover -- Madrid

Forbs and Cultivars

Australian saltbush -- Corto
Blue flax -- Appar
Rocky Mountain penstemon -- Bandera
Sulfur eriogonum -- Sierra
Palmer penstemon -- Cedar
Small burnet -- Delar

* No improved varieties now available

Smooth brome -- Lincoln, Manchar